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ROTUNDA

Fall 1973
Volume 6, Number 4

CHINESE TOMBS

COMET 1973F

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ROTUNDA

the bulletin of The Royal Ontario Museum

Volume 6, Number 4, Fall 1973

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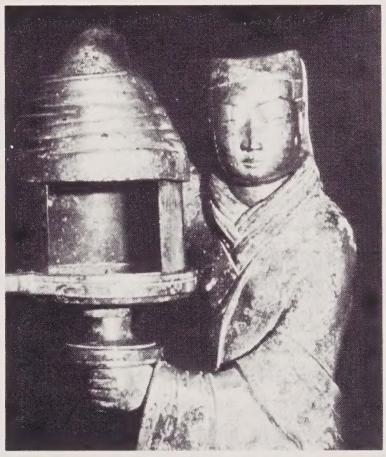


The cover: gilt bronze figure with lamp, 2nd century B.C., *China.*
See page 4

Focus

CAN OUR PAST BE SAVED?

Mrs. Stephen's article on China (page 4) prompts comparison with the state of archaeology in Canada. It is very easy to criticize our North American attitudes to the human past of this continent, especially if we compare them with the official patronage and financial support bestowed on the discipline in many countries of the so-called Old World; it is embarrassing to discover that the so-called "undeveloped" nations have more progressive legislation on the subject than we have. It is just as easy to be complacent, always to favour the immediate advantage—new power developments, new superhighways, new pipe-lines, or new real estate developments—over the long-run loss of cultural amenities and information about the past of our own land.

Rather than attempt to accuse or assign blame to any one arm of government, any one class of people, any one group whose needs and concerns seem to over-ride all other considerations, we must recognize that all of us—even the professional archaeologists—must share the responsibility. If nothing else, the archaeologists have failed to sell the idea to a majority of our people that the broken sherds, the flints, the rubbish from ancient occupations, have an importance and a relevance to their lives that make them worthy of consideration and preservation. One can hardly expect governments, at any level, to be very far ahead of popular views, especially when they may sometimes get the idea that archaeologists would like to save everything, no matter what the social cost.

Popular interest, however, can be gauged in various ways, and the interest in archaeology is growing rapidly. Teachers are inculcating into the minds of our children the significance of the past as a formative element in our present. They see, in the so-called "glamour" of field archaeology, a way of getting young people to "learn by doing," to get out and dig themselves. The theory and the practice have their own internal logic; unfortunately, a horde of school-children excavating an Indian site does not produce, let alone preserve, record and publish, the information one could desire. The net result is a happy day or two out of the classroom and the ruination of a rare, perhaps unique, historical record.

People are interested in the Indians and Eskimos and are fascinated with the tools and weapons they made. Such an attitude is laudable—until they engage in excavation to find their own specimens, or willingly buy arrowheads, pipes, or bone needles. Such purchases, sadly, encourage those merchants who systematically loot ancient sites to provide objects for the antiquities or art market.

Our governments—federal, provincial, municipal—recognize that attitudes are changing. People are no longer so impressed by the slickness and shininess of the new as contrasted with the hand-crafted products of our forebears. Our definition of the amenities of life now goes beyond efficient plumbing to beauty, beyond the modern and up-to-date to the historical, beyond the new car, new house syndrome to the values of past modes. Historic houses and public buildings are being restored, ancient sites receive monuments and plaques, books on the social history of towns and neighbourhoods are being written—and sold! Our parks are not merely places where nature can be experienced by city-dwellers; they have their little museums where the flora and fauna of the neighbourhood are illustrated and where the record of early man is also set forth. The intention is good, but the results are not always ideal. The Indians who once hunted game through the area, or who settled down in villages to cultivate corn and tobacco, cannot be understood fully on the basis of a single local excavation. The desire to make the archaeology of a small area relevant to the casual visitor may inhibit the fuller and deeper knowledge of the people who once lived there.

It would be absolutely wrong to accuse our developers, construction companies, planners and government agencies of cultural myopia, of putting immediate financial gain or economic advantage ahead of long-range values. Some of them may show a lack of conscience in such matters, but many of them have grasped the fact that people do not and cannot "live by bread alone." Pure economic considerations demand that they provide not only swimming pools and sauna baths, good parking facilities and communications, efficient equipment well-maintained and powered, but also clean air and water, a minimum of noise and confusion, green trees and grass, beauty, music, and colour. If an archaeological site is known to exist on the land they are planning to devote to new uses, or if some fine building already occupies part of it, more and more they are willing—if not eager—to see it preserved as part of the "character" or "individuality" of their new development.

But the mere desire to understand the past, and to turn it to our own uses, is not enough in itself. The best of motives can lead to the worst of results. To achieve the end desired and to avoid the worst mistakes, most archaeologists are agreed on certain basic requirements:

■ Any archaeological field work must be done by, or under the close supervision of, professionally trained archaeologists. Digging is not simply a matter of technique, of digging five-foot squares, of keeping the sides straight, of registering the finds in a methodical and accurate fashion. Far and beyond these requirements are the knowledge and experience, gained from study and from working at other sites, which the professional archaeologist can bring to bear in attempting to determine what *new* information the artifacts provide, and, consequently, what contribution they make to our general picture of the Indians or Eskimos of the area over many thousands of years.

■ Excavation is not an end in itself. The objects, the plans and sections of the dig, the photographs, the chemical and statistical analyses, the comparisons with similar finds made elsewhere, all must be brought together and published so that other scholars can use the new evidence.

■ The objects themselves must be treated with dignity and consideration. Some may well go on display in a local or national museum, but they must be provided with an intelligent commentary so that the interested visitor will understand their significance. What is not displayed must be kept in secure but available storage; such study collections, like the stacks of a great reference library, are the working tools of scholarly research. And the student cannot be expected to travel to dozens of small collections; there should be central collections, like central libraries, where type series from many sites can be studied.

■ All this will cost money. At present excavation is largely financed, directly or indirectly, by our governments. A few private foundations, corporations and individuals assist, but the need is far greater than they can meet. Today's massive earth-moving activities are rapidly destroying the traces of our predecessors. We should insist that the agencies responsible budget a small percentage of the total cost of the project to archaeological survey and, if possible, proper excavation, in advance of the bulldozer. Such a practice is normal in most countries today. It is not that the archaeologist insists that everything be saved. He only insists that we must know what we are about to destroy, for our archaeological and historical heritage is not a renewable resource.

■ Finally, to insure that the field work is done well, that the results are properly researched and published, and that the material is then used for public edification and for further scholarly research, there must be some system of licensing by qualified governmental bodies. Only thus can the ignorant, the untrained, the mercenary-minded, the opportunist be controlled in the interest of all our people and of all our descendants. Obviously, such regulation is going to tread on some toes and on some tightly-held views about private property vs the needs to conserve what is of interest and importance to all. But other countries, both capitalist and communist, have done it.

There is no doubt that Canada will eventually show a similar concern and respect for its past. There are, in fact, encouraging signs that this is happening already. But we must hurry to provide for the future survival of our past lest we be too late.

A. D. Tushingham
Chief Archaeologist

CHINA:
NEW PERSPECTIVES ON THE PAST

BARBARA STEPHEN

Early in 1973 arrangements were concluded in Peking to bring to the western world a unique travelling exhibition of recent archaeological discoveries from China. In April two planes carried the exhibition to Paris, where it was displayed throughout the summer. From Paris it flew to London, amid mounting excitement, where it is to remain until the beginning of 1974. After visiting two other European capitals it is expected to cross the Atlantic late next

Shang Dynasty bronze tripod vessel excavated in 1968 from Henan province, decorated with the figure of an owl, its body split to encompass part of the body of the vessel.

Among the discoveries at recent excavations in Beijing (Peking), site of the Yuan Dynasty capital Dadu, was this Qingbai ware porcelain figure of the Bodhisattva Guanyin.

Red earthenware bowl with painted decoration, from the site of Banpocun, near Xian, Shensi province.

This glazed earthenware figure of a camel carrying a foreign musical troupe was found in a suburb of Xian, in a tomb dated A.D. 723.

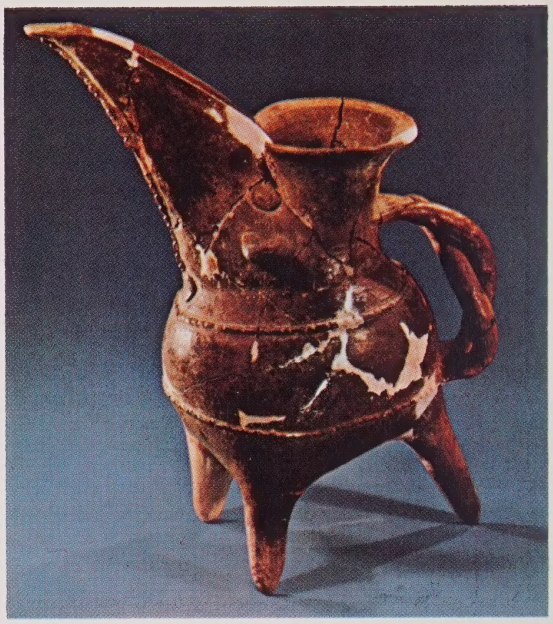
year. As this issue of ROTUNDA goes to press the ROM believes that the exihibition will be making its first North American stop in Toronto.

The contents of the exhibition are a surprise and a revelation to western viewers. Visitors who are used to thinking of Chinese art in terms of the decorative arts of the last four centuries find that the show contains nothing made later than the Yuan Dynasty, which ended in 1368. They discover over three hundred objects representing more than five thousand years of Chinese industry, excavated from the modest graves of neolithic farmers as well as from the underground palaces of the later nobility. The exhibition illustrates a continuous cultural tradition of great time-depth, and art forms that are both unfamiliar and compelling.

While many western museums display arts from ancient China, objects in this exhibition are of unusual interest. They have all been excavated by teams of Chinese archaeologists within the last twenty-five years, many within the past seven years, and the objects themselves are supported by photographs showing the field work in progress and the character of the sites. During this period the bare bones of China's past, known from ancient historical records as well as from excavations undertaken earlier in this century, have been fleshed out with a wealth of new knowledge gained from archaeological work conducted in many parts of China. This period equals in drama the earlier days of western archaeology, when the riches of classical antiquity and of the biblical lands were being unearthed. Photographs of the opening of the Egyptian tomb of the Pharaoh Tutankhamun, still packed with its wooden furnishings, may now be compared with views of the opening of the tomb of the wife of the Marquis of Dai, who after more than two thousand years of burial lay in a state of virtually perfect preservation amid an astonishingly complete array of household effects including dishes of fruits and meat.

Western imagination still surrounds China and Chinese culture with an aura of mystery, even though western interest in China may be traced back to antiquity. Before any certain knowledge of the remote areas of the Eurasian continent existed, the Greek historian Herodotus wrote that beyond the realm of the barbarians to the north-east lay the domain of the Hyperboreans, stretching to the sea; he may have been referring to China. Later, Rome knew China as the land of the Seres, where floss from the leaves of forest trees was sup-

Red earthenware tripod pitcher of the Longshan culture, from Shandong province. Longshan ceramic forms from this area are often elevated on tall and elaborate pedestals or legs. This pitcher has applied eyes and ears, and its opening suggests a gaping mouth.



Site of the discovery of Peking Man, at Zhoukoudian, Hebei province.

posedly woven into the luxurious fabric we know as silk. But the truth, that this fabric was produced from the filaments spun by silkworms, eluded the Romans, and silk and other eastern luxuries were imported along the far-ranging Central Asian silk roads. Fascination with China was already tinged with the allure of heady Asian spices, rare and costly tissues, and romantic far voyages.

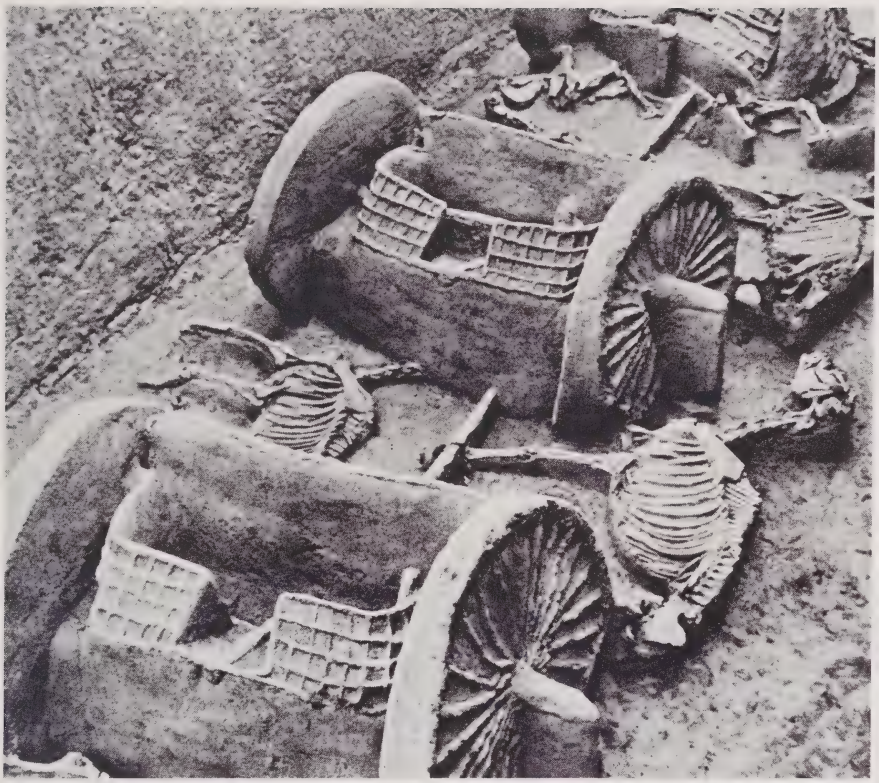
By the 9th century the secrets of silk production were known in the west, but another inimitable item of trade had appeared. From the 9th century onward Chinese ceramics, more durable and graceful than anything the west produced, were shipped in enormous quantities. It is still possible to walk the beaches of ancient ports on the Persian Gulf and have sherds of Chinese porcelain crackling underfoot as evidence of the great Arab trading ships that once sailed the Indian Ocean and beyond to bring Chinese ceramics to the western world.

By the late 13th century the impetus of Europe's mercantile explosion had led members of the Venetian Polo family to explore trading opportunities in China, and Marco Polo was for a time engaged in the service of the mighty Kublai Khan. His vividly romantic account of travels in far Cathay, the China of the Yuan Dynasty, fired the western imagination, and his impressions of China have coloured western thinking almost to modern times.

Early interest in China was basically trade-oriented, with only sporadic awareness being shown by occasional travellers of the richness and antiquity of Chinese culture. Later visitors began to acquire more appreciation for the ancient cultural tradition which the Chinese themselves valued so highly. Some, like the scholarly

Excavation of house foundations from the neolithic settlement at Banpocun, near Xian, Shensi province. New carbon-14 dates for this Yangshao site range from 4115± 110 to 3635± 105 B.C.

A Shang Dynasty cruciform royal tomb at Wuguancun, Anyang, Henan province. Excavations in 1950 revealed that the central part of the tomb had been extensively robbed in antiquity, but subsidiary burials were intact. This view into the excavation shows the skeletons of sacrificial victims, both people and horses.



A multiple chariot burial from the Zhou Dynasty cemetery site at Shangcunling, Henan province. The burial was associated with rulers of a state which was annexed in 655 B.C. and is thus dated earlier, 8th to 7th century B.C. Each chariot was buried with its two horses.

Jesuits who found a place at the imperial court in Peking in the 17th century, studied the Chinese language and explored the literary and philosophical heritage. In our own century western scholars have sometimes been able to contribute to knowledge of China's past, as in the case of the discovery and identification of the fossil remains popularly known as Peking Man. This hominid, who lived in China around half a million years ago, was found and classified by Chinese scientists working with a number of western specialists, including an Austrian palaeontologist, a Swedish geologist, and a Toronto medical man, Dr. Davidson Black. Together they first established in the eyes of the world the great antiquity of man in China.

While serious western study of China's past is only a few centuries old, the Chinese themselves have a long tradition of scholarly research into their own antiquity. By the late Bronze Age people had already come to treasure the bronze vessels made in earlier centuries. As early as the 3rd century A.D. occasional discovery of old tombs had begun to excite scholarly interest; records reveal that a tomb opened at this time yielded documents written on bamboo slips about six hundred years before. Contemporary scholars and historians, having lost many valued historical records earlier as the result of a short-lived imperial policy that decreed the destruction of much literary material, were delighted. Interest in ancient objects reached a peak during the Song Dynasty (A.D. 960-1279), and remained strong in the centuries that followed.

Modern scientific archaeology began rather later in China than in the western world, where the systematic exploration of ancient sites was well established in the 19th century. In China the closing years of the Qing Dynasty (A.D. 1644-1911) were troubled ones, and the ensuing decades of the first half of the twentieth

century were even more turbulent. During the 1920s and 1930s Chinese archaeologists gathered basic information on prehistory and on the early historical periods. Work done in these years made it possible to verify some of the historical records of the past, viewed by the more skeptical scholars of the day as little more than legend, and to correlate them with finds of ancient objects unearthed from Chinese soil. Among the most widely publicized excavations of this period were those at the Bronze Age capital site at Anyang, in Henan province.

Since 1949 the government of the People's Republic of China has actively encouraged archaeological exploration, and a prodigious amount of work has been done. Excavation has continued at sites of national importance, such as Anyang, and at the locations of other early capitals near the modern cities of Xian and Luoyang. Protective policies have been designed to put an end to the clandestine digging at well-known sites that had plagued archaeologists in earlier years. At the present time there seems to be widespread awareness of the importance of reporting any finds so that they can be recorded and investigated, and excavations can be planned and undertaken where necessary. One of the greatest construction programmes in recent years, at the Sanmen gorges on the Yellow River, had resident archaeologists with authority to stop work in progress if archaeological material turned up that required attention and further exploration.

Although the results of archaeological work done in China since 1949 are still not well

known to the public, western scholars have received regular information both in specialized journals and in fuller excavation reports. In 1966 however China launched the Great Proletarian Cultural Revolution, and one of the results was that archaeological reporting abroad suddenly ceased. From 1966 to 1971 there was almost complete silence on the subject, and some western scholars began to fear that archaeological work in China had stopped. Late in 1971 came the first indication of change, heralded by the publication in a popular North American fashion magazine of some French colour photographs of two burial suits made of jade plaques held together with gold wire. The suits had been excavated from a Han Dynasty tomb of the 2nd century B.C. during the cultural revolution. While the suits were of a hitherto undiscovered type and thus of great interest, even more important was the news that they were on public display in Peking, in an archaeological exhibition. Since that time, archaeological journals and reports have again been reaching the Far Eastern Department library with great regularity.

Many of the objects selected for the exhibition now travelling in Europe and expected in Canada next year were excavated during the cultural revolution. They have been supplemented with other pieces of special interest excavated between 1949 and 1966 in order to give a more complete view of the whole range of China's cultural history.

It is no exaggeration to say that knowledge of ancient China has been revolutionized by archaeological finds made in the past twenty-

Visitors looking at the jade burial suit of Liu Sheng at the Peking exhibition of archaeological finds made during the cultural revolution. The suit was made of more than 2000 small pieces of jade, bound together with gold wire. Though jade was believed to prevent decay, the body within the suit had returned to dust.

The central chamber cut into a rocky cliff of the tomb of Liu Sheng, Prince of Zhongshan, Western Han Dynasty, 2nd century B.C. The tomb, discovered in 1968, had an entry way, a large central chamber, and a rear chamber containing the burial. Each section of the tomb contained burial goods including both mortuary objects and articles designed for daily use.

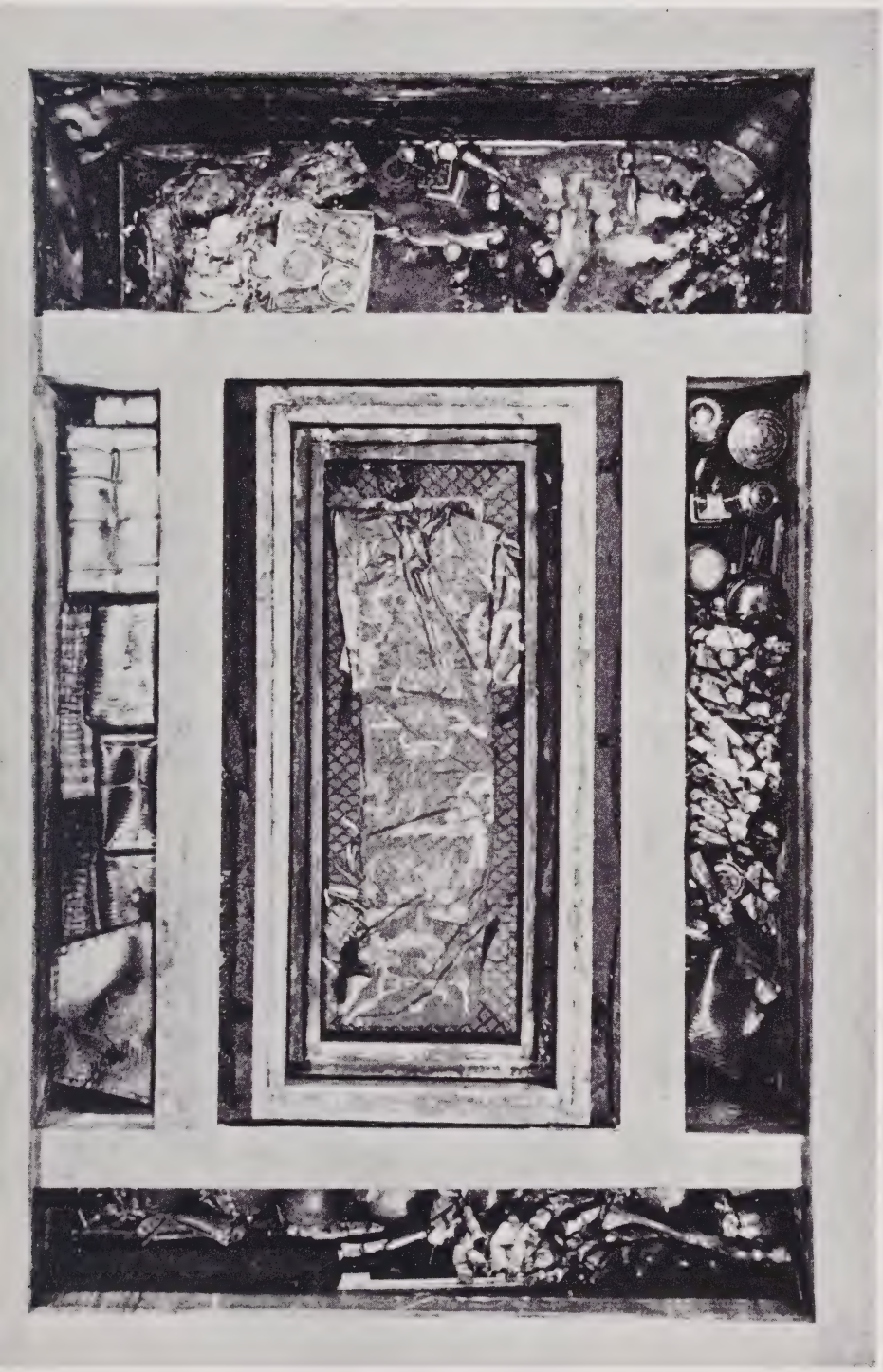
five years. Some of the most significant discoveries have been made at neolithic sites, and scholars are now able to form a much clearer idea of the early development of settled agricultural communities in China. Later Chinese culture owed much to these first farmers who, in the thousands of years before the introduction of metallurgy during the second millennium B.C., established the foundations of Chinese civilization. The earlier of the two principal neolithic cultures of China, the Yangshao, was characterized by the use of ceramics with painted designs, and by the cultivation of millet. Some scholars now think that this valuable cereal may have been first domesticated in China. Excavations of many neolithic sites in the past several decades have provided much more information on the distribution and development patterns of these early cultures, and archaeologists are now able to identify regional cultures within the two main traditions.

Until very recently one of the continuing problems facing students of China's prehistoric past was the lack of any means of dating early cultures. Not only was it difficult to compare these cultures with those found in other parts of the world, it was usually impossible to say with any assurance which sites within China were earlier than others. One of the most exciting recent developments has thus been the first publication in 1972 of an initial series of carbon-14 dates for China's neolithic sites. These dates have begun to enable archaeologists to place neolithic cultures on an absolute time scale. Some of the sites of China's second principal neolithic tradition, the Longshan, have been dated unexpectedly early. As these early Longshan farmers were already cultivating rice, carbon-14 dating suggests that rice, like millet, could first have been domesticated in China rather than in India, where the earliest rice appears several thousand years later.

From the early Bronze Age onward, when historical records often illuminate archaeological finds, it has in some cases proved possible to associate important burials with particular individuals whose activities are described in the histories. Research on the plans of ancient cities has permitted archaeologists to relate finds to particular households. Through analysis of the location in which it was found, one Tang Dynasty (A.D. 618-906) hoard of gold, silver, and other precious objects was linked with one family. The hoard was found buried in jars on the site now known to have been occupied by the house of a family closely related to the Emperor. It is thought that when the Emperor fled the capital during the rebellion of 746 a prince from this household may have accompanied him, first burying the family treasures to safeguard them from looters. For some reason their location was lost for more than a thousand years.

While many of the most spectacular recent archaeological finds come from the tombs of the wealthy and the nobility, other finds reveal aspects of life which affected all levels of society. In Luoyang, eastern capital of the Tang Dynasty, remains of the great Tang granary which stored tax payments of grain were uncovered during 1969-70. It contained about four hundred large storage pits, provided with a wooden substructure which permitted air to circulate and prevented the grain from becoming mouldy. An earlier find from Luoyang, made in 1964, was the discovery of five hundred and twenty-two burials of criminals of the Han Dynasty, dating from the early 2nd century A.D. Information on inscribed bricks was included with the burials, often giving details of the sentence the person had received and the class of offence. They also tell us that many of the prisoners, who had died while serving their sentences, had been transferred from other jails, sometimes from considerable distances. The purpose was probably to recruit labour for use in the capital, for historical records tell of prisoners working on palace and tomb construction as well as on public works such as bridge or road-building.

Western visitors to the travelling archaeological exhibition, or indeed anyone reading news releases or seeing contemporary films on archaeology prepared in China, are confronted with unfamiliar terminology. Description of



2nd century B.C. tomb of the wife of the Marquis of Dai, on the outskirts of Changsha, Hunan province. The inner coffin was covered with a painted silk banner, and was surrounded by grave goods including food, musical instruments, and lacquer vessels as well as many model figures of attendants.

The Mongol rulers of the brief Yuan Dynasty (A.D. 1271-1368) made Beijing (Peking) their capital. This recently excavated barbican or fortified gateway was part of the hastily built Yuan defence system for the city.

early cultures by the Chinese is now based on an historical scheme which emphasizes the "productive forces" on which the development of successive social systems is thought to depend. This scheme expresses human history in terms of five consecutive systems labelled primitive social, slave-holding, feudal, capitalist, and socialist. In terms of the periods represented in the exhibition, primitive society covers the long span of human development from the earliest times to the late neolithic. At this point class society is seen to have developed, together with a pattern of exploitation of the labour of the working people which characterized most later history prior to the advent of socialism.

Not only is cultural history expressed through the use of different concepts, even the scheme of romanization used for Chinese terms has been changed to an official new system. Western readers accustomed to the Wade-Giles romanization, used in most English language publications in recent years, will have some difficulty recognizing the dynasty they have known as 'Ch'ing' under its new guise as 'Qing', or the ancient 'Chou' Dynasty, now romanized as 'Zhou'. This new system has an enormous advantage over its predecessors because it is international, not developed for one western language or another. For this reason it has been used throughout this article, and visitors to the Far Eastern Department galleries will be seeing more of it in the future as labelling is gradually changed.

The archaeological exhibition expected in Toronto next year represents a period of renewed cultural exchange between China and the western world and will do much to familiarize our public with the wealth and fascination of China's ancient tradition. The support of a revolutionary regime for study of the aristocratic arts of antiquity may at first seem to be inconsistent. Such arts are however regarded as precious evidence of the talent and industry of the working people of ancient China. Their handiwork, viewed as having previously been appropriated by the slave-owning or feudal members of the ruling class for their own use, is being returned to the working people of today by the archaeologists of modern China. Archaeological excavations are also thought to provide valuable instructive information on the class struggle in ancient China. Support in principle for archaeology may be found even in the words of Mao Zedong, who as early as 1942 was exhorting his supporters to "take over all the fine things in our literary and artistic heritage, critically assimilate whatever is beneficial, and use them as examples when we create works out of the literary and artistic raw materials in the life of the people of our own time and place". With such encouragement, we can expect many future revelations from China's growing ranks of archaeologists.

Barbara Stephen is Associate Curator of the ROM's Far Eastern Department, where the prospect of next year's exhibition of Chinese archaeological treasures sponsored by the People's Republic of China is generating great enthusiasm. Mrs. Stephen is particularly interested in the Chinese Bronze Age. A spin-off from her Bronze Age studies—Wheels for the Dragon—was published in ROTUNDA, Fall, 1970, and a book on the chariot in Shang China is now in preparation.

FIERY OMENS OF THE SKIES

Comet 1973f

ROBERT BALLANTYNE

On March 7 of this year Lubos Kohoutek, an astronomer at the Hamburg Observatory, discovered that a faint diffuse object was moving through the solar system toward the sun. This was the prologue to one of the most fascinating events in astronomy, the appearance of a great comet in the skies above the earth.

In April Comet Kohoutek, or Comet 1973f, was inside the orbit of Jupiter and still so faint that it could only be detected on telescope photographic plates.

By May, the evening twilight was causing the sky around the comet to be so bright that it could no longer be seen.

Comet 1973f reappeared in the early morning sky at the end of September. By then it was much closer to the centre of the solar system and bright enough to be seen in small telescopes.

In November it should become visible to the unaided eye as a faint hazy ball of light. As the days pass it will move across the sky, changing shape and growing in brilliance as it continues to approach the sun.

Comet Halley, May 1910. Courtesy Hale Observatories.

During the first half of December it will seem to move rapidly towards the sun in the sky and at the same time it will become considerably brighter. In spite of the fact that the closer the comet is to the sun the harder it is to observe, there are indications that this comet may become bright enough to be seen near the sun even during the daytime.

Comets, fuzzy patches of light that move very slowly among the stars, often develop a "tail," a nebulous streak extending from the head of the comet. Night after night the comet will shift its position and change its shape. It may remain visible for a few days or a few months.

Most of the comets that journey through our part of the solar system are too faint to be seen by the unaided eye. Once every few years a dim glow appears in the sky but, because most people do not know where to look, another comet may pass almost unnoticed. A great comet, however, is a once-in-a-lifetime event.

In 1705, Edmund Halley published calculations relating to the orbits of 24 comets. He made special reference to the fact that the bright comets of 1531, 1607 and 1682 had such similar orbits that they could be the same object—which should therefore return in 1758. The comet was in fact spotted on Christmas night, 1758. Halley's comet, as it has come to be called, was the first comet to be identified as a permanent member of the solar system.

Comet Kohoutek against the Toronto skyline, in the constellation of Libra, on December 14, 1973. This planetarium simulation probably exaggerates the size and brilliance of the comet for that day.

There are historical records of each passage of that comet every 74 to 79 years since 240 B.C.

Many comets return regularly. Those with the longest known periods are Comet Rigollet, Comet Halley and Comet Pons-Brooks, which return every 151 years, 76 years and 71 years, respectively. The comet with the shortest period, Encke, returns every 3.3 years.

Most comets, however, appear unpredictably, emerging from the dark reaches of distant space to pass close to the sun, blossom by its light and heat, and then vanish into the unknown.

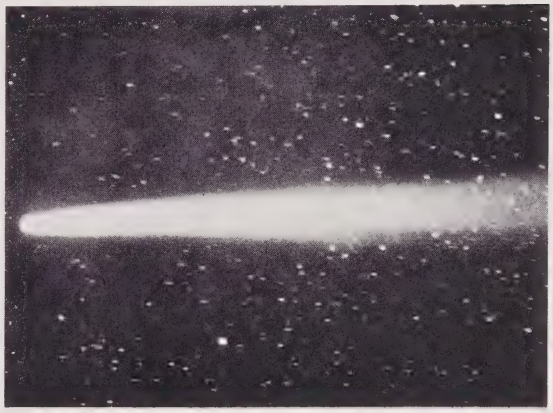
Aristotle of ancient Greece imagined that comets were poisonous vapours, exhalations from the earth that ignited in the atmosphere. Until the 17th century comets were thought to be such sub-lunar phenomena. People believed comets to be omens, and the omens were always bad. Even today, the appearance of a comet seems to generate fear and apprehension.

Comets may be huge objects in the solar system, but they are actually composed of very little material. The head of a comet is typically about a hundred thousand miles across and so tenuous that stars can be seen shining through it, their light almost undiminished. The composition of comets is still largely a matter for speculation, but current research suggests that they are probably made of methane, ammonia, water and possibly lesser quantities of rocky or metallic material.

All the comets which are distant from the sun must be frozen solid. As a comet approaches the sun, heat vapourizes some of the gases. Sometimes radiation from the sun forces gases away from the comet into long tails. At first glance, the tail seems to be trailing behind the comet as it streaks through the solar system. This is almost never true. Since it is formed by solar radiation, the tail usually is driven radially away from the sun.

There are believed to be two ways in which the sun can generate the comet's tail. Radiation pressure is the action of sunlight pushing against cometary material. If a photon of electromagnetic radiation strikes a comet particle, its momentum is transferred to the particle and accelerates it. On the tiny particles in interplanetary space, this force of solar radiation can be greater than the sun's gravitational attraction, and the particle will move away from the sun. This can account for the formation of the tails.

Comet Mrkos, August 1957. Courtesy Lick Observatory, University of California.



The sun is also ejecting charged atomic particles into space, producing the solar wind. This wind of ionized gases is continuous but variable. When the solar wind impinges upon the comet, any charged particles are driven by electrostatic repulsion into the tail. Variations in the solar wind may account for the sudden changes sometimes observed in the features of a comet's tail. It has been demonstrated that straight comet tails with high accelerations are composed of a high proportion of ionized gases, while the more curved tails are made of solid particles and neutral molecules.

In our solar system, the orbits of plants are nearly circular and the most distant planet takes 248 years to travel around the sun. Comets, on the other hand, usually have very long, elliptical (cigar-shaped) orbits. One end of the orbit might be closer to the sun than the planet Mercury, and the other tens of thousands of astronomical units away (1 astronomical unit equals the distance from the sun to the earth). The orbits can be so large that the comet might pass the sun only once in recorded history.

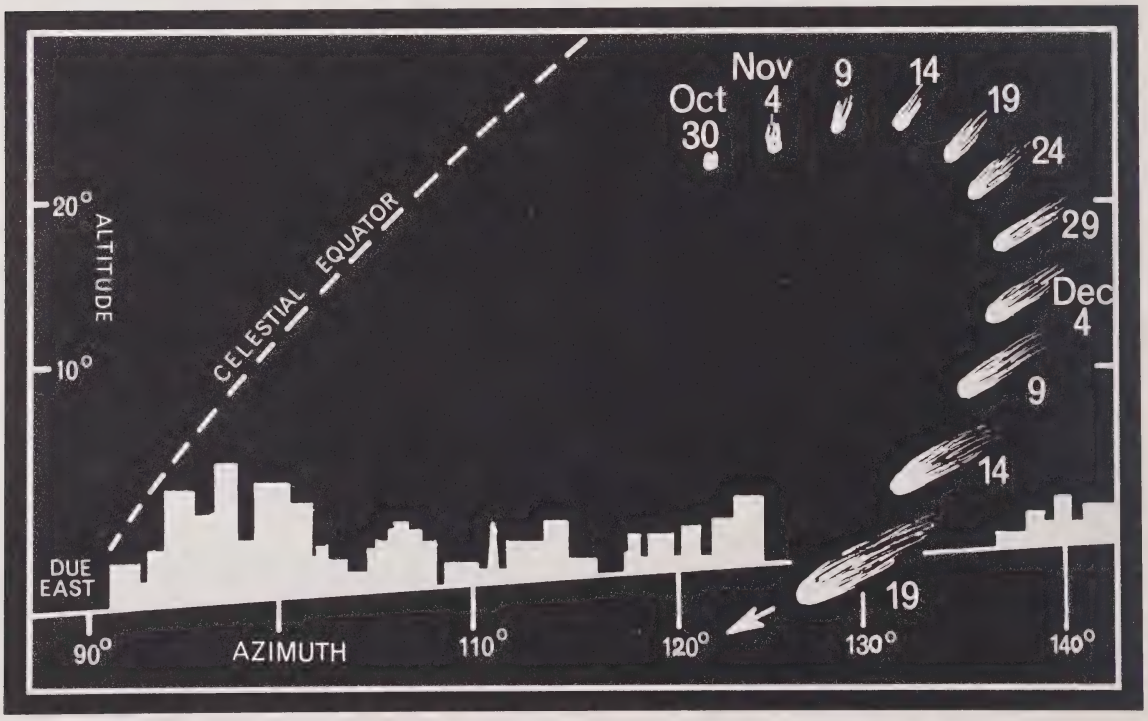
When the comet is far from the sun it moves very slowly. During its approach to the centre of the solar system it accelerates. As it passes perihelion (closest point to the sun) it is moving very rapidly. Tidal forces from the sun often severely damage the comet. In 1846, Comet Biela was divided into two comets as it dashed around the sun. Both comets reappeared in 1852 on the same orbit, but neither has been observed since.

The origin of comets and their place in the story of the solar system is a mystery. Since all of the cometary material that forms the tail is lost to the comet forever, and since only the disintegration of comets is observed and never their formation, it would seem that some day all the comets will be gone. Yet the solar system is five billion years old and all the comets have not been destroyed. How are new ones formed, and where do they come from?

Jan Oort, a Dutch astronomer, has put forth the most popular notion. He suggests that 50,000 to 150,000 astronomical units from the sun there might be an immense cloud of comet material, perhaps some of the original stuff from which the solar system was formed. Other stars near the sun would have an effect on this comet material. Some of the comets would be forced to journey off into interstellar space, while others would fall toward the sun. Only the latter would be observed by the inhabitants of the earth.

Oort believes that there may be more than one hundred billion comets remaining in that cloud, but since they are so light their combined mass would be about 2% of the mass of the earth.

Although people no longer fear comets for superstitious reasons, there is usually some consternation about the possibility of a collision between the earth and a comet. In 1910 our planet seemed to pass through the tail of a comet. In spite of the fact that no effect was or could be felt on the earth, some profiteer



did very well by selling comet pills to counteract the "ill effects."

On June 30, 1908, a comet exploded in the atmosphere over the Tunguska River region in Siberia. Trees were felled over a 20-mile radius, 1500 reindeer were killed, and a man was knocked unconscious at his home 50 miles away. This was a rare event. Comet Kohoutek will never be closer than 75 million miles from the earth.

On December 28 it will be at perihelion, only 0.141 astronomical units from the sun. During this period it might be seen as a silvery streak near the sun in the sky. A few days after perihelion, it will be part of the sunset.

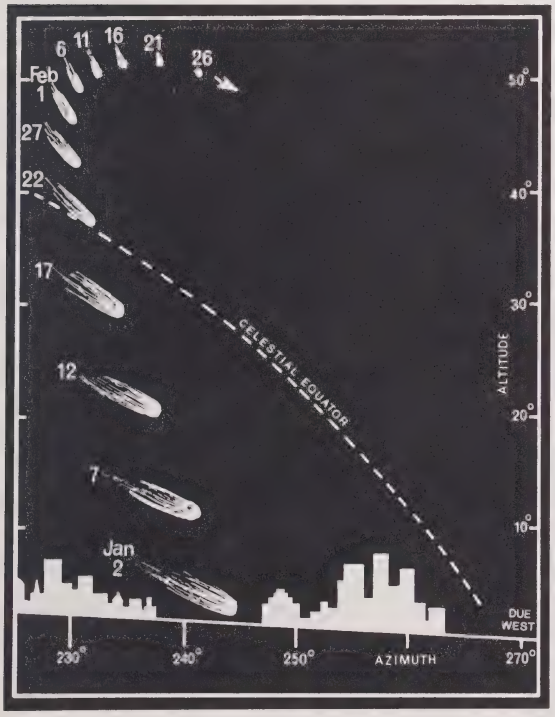
For the first couple of weeks of 1974 the comet should be clearly visible in the evening. Each day it will move a little higher in the sky, a little further from the sun, and become a little fainter.

During February a pair of binoculars might be needed to locate the fading comet. Its long journey away from the sun and into the unknown reaches of space will have begun. Astronomers may be able to track the comet for about a year, but then it will be lost to us forever.

Around the world scientists are preparing to take advantage of this unique opportunity to observe a great comet. Observatories have been rescheduling their telescopes to allow for a wide variety of experiments. Skylab astronauts will be required to use some of their instrumentation to collect further data on 1973f. The unmanned spacecraft, Orbiting Astronomical Observatory #3, will make spectrum scans of the comet, and Orbiting Solar Observatory #7 will take pictures.

At the McLaughlin Planetarium of the ROM, the theatre schedule has been altered to allow for a special programme about comets and the Solar System (scheduled to begin November 2.)

Although the path of Comet Kohoutek



Comet Kohoutek's position in the morning (far left) and evening (left) skies above Toronto about an hour from sunrise or sunset. Above, Comet Halley and Venus, 1910, photo courtesy Science Museum, London.

through the solar system has been accurately forecast, its appearance in terrestrial skies is still a matter of speculation. We are all waiting to see how it will behave. The chart accompanying this article should enable you to see 1973f and watch the events as they develop.

A sketch comparing the size of four different comet heads with earth

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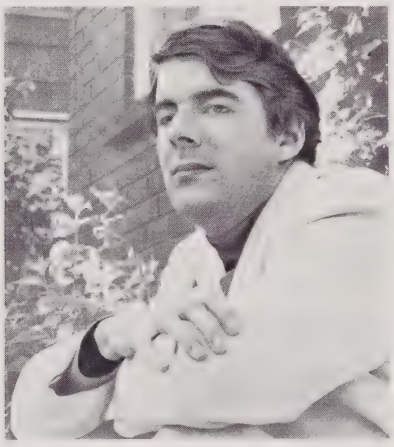


Robert J. Ballantyne's active involvement in astronomy goes back many years. A native of Montreal, he joined the staff of the Dow Planetarium as a lecturer in 1965, later becoming a show producer. He joined the staff of the McLaughlin Planetarium three months before its official opening in October, 1968, and since that time has lectured and created a number of planetarium shows for the Theatre of the Stars. Among these are It's About Time, The Christmas Star, Denizens of Outer Space, Man and the Zodiac, and Drama of the Stars. He is President of the Planetarium Association of Canada, and a member of the Royal Astronomical Society of Canada and the International Society of Planetarium Educators. At the present time, he is preparing a show about comets to be presented in the Theatre of the Stars late this fall.

The Growing Collections

The most spectacular recent acquisition of the Department of Mineralogy is a specimen of torbernite from Zaïre (16 x 10 x 10 cms) completely covered with rosettes of brilliant green tabular crytsals up to 1 cm on an edge. An attractive, rare specimen of dodecahedral crystals of bornite (the largest 2.5 cms in diameter) on clear quartz crystals is from the Republic of South Africa. Scheelite crystals, up to 3 cms on an edge, on a large quartz crystal (11 cm long) make a very attractive piece; another scheelite specimen is a large single crystal, 6.5 cms on an edge; both of these are from Tong Wha, Korea. Also from Korea is a fine ferberite crystal (6 x 3 x 0.5 cms). A group of scolecite crystals from India, consisting of crystals arranged in three narrow intersecting sprays (12 x 1.5 cms each) makes an aesthetically beautiful specimen of this unusual zeolite. Honey-brown eosphorite crystals from Brazil arranged in rosettes (up to 1.5 cms in diameter) scattered on a crust of rose quartz crystals is also a fine addition.

A fine rutile crystal (5 x 5 x 4 cms) on an attractive iridescent matrix (14 x 11 x 8 cms) from Graves Mountain, Georgia, and an excellent specimen with brilliant pyrrhotite crystals (up to 2.5 x 2.0 x 0.7 cms) on dolomite from Brazil, are also important additions.

A particularly gratifying acquisition, made possible by a generous donation from the Oshawa Rock and Mineral Club, is illustrated here. It is a magnificent specimen of purple fluorite crystals perched on a white celestite crystal. The base of fluorite (about 10 x 10 x 10 cms) supports the long celestite crystal which is 38 x 9 x 2 cms in size partly coated with the fluorite crystals.

The Department of Vertebrate Paleontology has recently purchased from Princeton University a number of very interesting specimens: several partial and reasonably complete ichthyosaurs, a complete marine crocodile, a mounted skeleton of a moa, two slabs of dinosaur footprints, and dozens of other specimens largely of research interest. The most important material is that of the ichthyosaurs, porpoise-like reptiles that lived in the sea during dinosaur times. Rosemary Johnson is shown examining an ichthyosaur jaw from among the Princeton purchases.

An 18th century Chinese carpet will soon join the group of Far Eastern carpets displayed in the Chinese furniture gallery. This recent acquisition of the Far Eastern Department is the gift of a group of private donors in memory of Harold B. Burnham, the late Curator of the Textile Department. It is a fitting tribute to a man whose far-reaching knowledge and interest extended to the textiles of the Orient. Mr. Burnham's articles on weaving and weaving technology during the Han Dynasty and his monograph on the development of Chinese velvet weaving are major contributions to scholarship.

This carpet is unusual both in terms of the ROM's collections and of the larger body of Chinese knotted rugs. The subdued blue and gold colour scheme and lustrous sheen of the wool pile are qualities admired in fine rugs; however, its informal design diverges from the more common and hence better known formal Chinese types.

Human figures are rarely included in Chinese carpet designs. The seventeen babies prominently displayed here represent the "One Hundred Children," a traditional marriage theme expressing wishes for progeny. Four sets of lucky symbols—the eight Buddhist symbols, eight Taoist symbols, objects symbolizing the four accomplishments of the gentleman, and flowers of the seasons—elaborate the propitious theme.

The outer border with framed panels, separated by a variety of diaper patterns, is also an unusual carpet design. This ornamental device, derived from porcelain decoration, is more typical of the painter's, rather than the weaver's art.

A mid-18th century or slightly earlier date is supported by several stylistic features. The symbolic complexity, the shaded three-dimensional effect of the square meander border (which was possibly influenced by ideas of Western perspective), and the elaborately ornamental border which has precedent in early 18th century enamelled porcelains are characteristic of Ch'ien-lung period (1736-1796) decoration.

GRIM KEEPS AND FABULOUS GABLES

Chateaux and castles of France

COREY KEEBLE

Chenonceaux, mirrored in the waters of the River Cher, was erected in the 1500s. From Réné-Jacques' Chateaux of the Loire, *courtesy Wilhelm Andermann Verlag, Munich.*

The forbidding battlements and donjon of Ghent, c. *1180. From Toy's* History of Fortifications, *courtesy Wm. Heinemann Ltd.*

Francis I of France once referred to the Chateau of Chenonceaux as the most agreeable mansion in his country, and it is indeed a jewel of architecture. Set on the piers of an old mill on the river Cher, the central portion, with its clusters of roofs, pinnacles and gleaming white chimneys, was built between 1515 and 1523. Between 1556 and 1559 a bridge was built connecting the chateau and one bank of the river, and then, in the 1570s, Catherine de Medici had a palatial extension of the chateau constructed on top of the bridge. The resulting ensemble of architectural styles reflected in the waters below is like a dream vision, a fairy-tale palace.

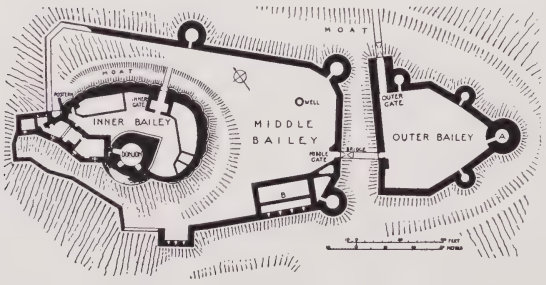
Equally impressive, equally poetic visually is the small chateau of Azay-le-Rideau set on oaken piles sunk into the bed of the Indre. Dating from 1518-1527, and constructed in an almost playful blend of Gothic and Renaissance styles, it stands serene in its watery setting against a backdrop of rich verdure.

Here the steps of the courante, tourdion or galliard, French dances of the 16th century, would be more familiar than the tread of marching feet, and the sounds of lute and harp would be more familiar than the alarums of war.

It had not always been so. Chenonceaux and the other chateaux of the Loire stand as descendants of more martial forebears constructed in a grimmer, earlier age.

The struggles which had shattered the fabric of the Roman world and ushered in the Dark Ages had reddened European soil with the blood of generation after generation. Just as European society began to

Mehun-sur-Yèvre, from the Très Riches Heures of Jean, Duc de Berri: not easily defended, a castle with lacy pinnacles and swans in the moat. Second half of the 1300s. Courtesy of Musée Condé



Plan of a castle based on the medieval motte and bailey design. Courtesy Wm. Heinemann Ltd.

recover from these shocks and the migrations of barbarian hordes, a new wave of invasions in the 9th and 10th centuries brought more destruction. Incessant warfare became the norm.

The response to the new danger was the creation of the system we call feudalism. One of its first aims was military, but it solidified into a political and social system which was to last 500 years, and which created an aristocracy supported by the labour of a peasant class existing to till the land. Land became the primary indicator of wealth, and in the initial phases of the feudal system was offered in return for service of a military nature.

The feudal aristocracy were first and foremost warriors. Feudalism's most immediate concern was for protection, not of some abstract entity called "the state," but of the immediate local community. By the 12th century Europe was dotted with thousands of castles, ranging in size from enormous complexes of wards to single, small stone towers. For defensive purposes, castles were placed so as to be as nearly inaccessible as possible. Around them were small communities of peasants, gathered together in a cluster of rude huts. There would be perhaps a mill, bake ovens, all the property of the lord of the castle or of the manor, and perhaps also a small chapel. The pattern of life in such an environment was austere to say the least.

Among the earliest French and British castles of the mediaeval period were those of the so-called motte and bailey type. The motte or mound ranged in diameter from 100 to 300 feet, and varied in height from ten to 100 feet. Set on the top of the motte was a strong tower to which the garrison could withdraw in the event of a siege. The tower was surrounded by a wall or stockade, at first of wood and later of stone. Connected to the motte was a bailey or ward, also surrounded by a wall or stockade, containing buildings such as stables, barracks, smithy and storage buildings, which in time of siege sheltered the peasants and the cattle. The whole complex was enclosed by a ditch. In form and function these castles were similar to the

Azay-le-Rideau was built in the early 1500s, and with Chenonceaux stands as one of the most perfect examples of Loire chateau architecture. Courtesy Wilhelm Andermann Verlag, Munich.

pioneer forts of the last century, where defence was more important than creature comforts.

In the 12th and 13th centuries castle-building took on a more formidable nature. Many castles came to be dominated by brooding rectangular citadels called donjons or keeps. Stone keeps were known at Brionne, in France, as early as 1045, and at Gisors there is a stone keep dating from about 1160. The purpose of such elaborations was always to make the castle more siegeproof and to this end they were placed in even more remote areas.

The Crusades taught Europe new lessons in the art of siegecraft. The fortifications of the Levant, particularly those of the Byzantine Empire, had a strong influence on the development of fortifications in the West. The corners of rectangular towers had proved weak points. They were susceptible to mining or undercutting, and it was difficult to provide effective covering fire from their battlements. Round towers of the type at Roumeli Hissar, built about 1100 not far from Constantinople, were echoed in Europe, first by transitional towers such as those at Houdon (*c.* 1130) with a square interior and rounded external projecting turrets, and later by those at Provins, dating from the middle of the 12th century and polygonal in cross-section, and Etampes (*c.* 1160) of quatrefoil form. Later, round towers with systems of encircling walls, again strongly influenced by the military architecture of the East, were introduced. The wards of the castle were grouped along long axes or arranged concentrically, to provide the most comprehensive system of defence possible.

Up to the end of the 13th century, military considerations were dominant. The living quar-

Etampes of the 1100s is today a ruin, but its portrayal in the Très Riches Heures is a record of its past magnificence. Courtesy of Wm. Heinemann Ltd. and Musée Condé

Blois, built in the 1200s on the Loire. In the 1500s Francis I added the famous spiral staircase which later became one of the most striking features of ornamental palace design. Courtesy Wilhelm Andermann Verlag, Munich.

ters, even of some of the greatest castles of the most powerful barons, were by modern standards almost painfully austere. The barons were country people, living far from the new cities just then beginning to emerge. Their manners were as rough as their fingernails, and life was regulated by the necessities of the profession of arms. At the age of seven a boy was already learning the ways of war, and his training continued up to the age of 21 when the time came to put his skills into practice.

This rough breed saved Europe from disaster, but in time the cure threatened to prove worse than the disease, for no sooner had the warrior class beaten off foreign invaders than it began war internally in a constant jockeying for greater advantage, more power, more territory. But by the 14th century the dominance of the feudal aristocracy was challenged by the very society it had brought into being, first in the realm of the economy and later in techniques of warfare, the very backbone of the power of the aristocracy.

The rough stability which the feudal aristocracy had succeeded in bringing to Europe permitted the revival of trade and commerce and the introduction of new forms of power and wealth. From the 10th to the 13th centuries urban Europe underwent a revolution in its development, and one of its far-reaching consequences was to put a previously unknown power in the hands of the rising bourgeoisie. This group of merchants, the wealthy but non-noble stratum of society, challenged the power of the nobility which was based on birth, land and military prowess, and increasingly tended to ally themselves with the sovereign against the nobles.

In the 14th century, the aristocracy's monopoly of warfare was effectively challenged by the rise of the English longbowman and the continental pikeman. At the battle of Courtrai in 1302, an army of Flemish foot soldiers, recruited from the townspeople under the command of a weaver named Conink, defeated the pride of European chivalry under the command of the King of France. At Crecy, in 1346, the French suffered a terrible defeat at the hands of an English army whose main strength lay in the commoners' use of the longbow. In Switzerland, in 1315 and again in 1386, Swiss pikemen and halberdiers humbled the might of Austrian feudal cavalry.

In each case the lowly foot soldier, who had so long counted for very little on the field of battle, overcame aristocratic cavalry. It was a sign of things to come. It heralded the day of the professional soldier recruited at random from the populace, the later-16th-century mercenary fighting for anyone who guaranteed to pay him, and the 17th and 18th-century professional soldier of national armies fighting for the state. That so many of the infantry were townsmen was also significant, for the rise of the towns was beginning to change the whole way of life of all Europeans, rich and poor.

It is in the 14th century that the domestic aspect of castle design is first seen to challenge primarily military considerations. Trade brought a higher standard of living, and the castle began more and more to take on the appearance of a luxurious dwelling. The Très Riches Heures of Jean, Duc de Berri, dates mostly from the years 1411-1416. Its calendar illuminations show that something happened to the lives of the European aristocracy in the early 15th century to make them significantly different from what had gone before, and the differences are hinted at by architectural detail.

The miniature for March shows the castle of Lusignan, parts of which date back to the 12th and 13th centuries, and include complex systems of battlemented walls and strong round towers. In the 14th century these relics of a harsher, harder time were supplemented by new buildings of a more luxurious, comfortable and roomy type. Fanciful tall chimneys and gables contrast with the brooding grimness of the older, more fortress-like parts of the castle. In the foreground a ploughman scratches the ground with a crude plough, and labourers prune trees and tend sheep—a reminder of the paramount importance of land, the foundation of the whole feudal system. Earlier, the castle had been intended to be as self-sufficient as possible. By the 14th century, many feudal landholdings produced more than could be used by the castle community alone. Sheep were

kept in large numbers, and the wool trade had reached such enormous proportions that by the 15th century the wealth of barons and of many towns depended upon it.

April's miniature shows the castle of Dourdan, built around 1220 but altered by the 15th century by improvements in the domestic apartments. Some astonishingly large windows relieve the harsh monotony of one of the curtain walls of the castle, and tall peaked roofs and large gabled windows rise above the battlements. Windows, which let in light and air, indicate the predominance of other than military considerations. The hint of luxury and leisure they provide is reinforced by the foreground, which shows not peasants but lords and ladies, in the elaborate and theatrically decorative garments of the International Gothic's later period.

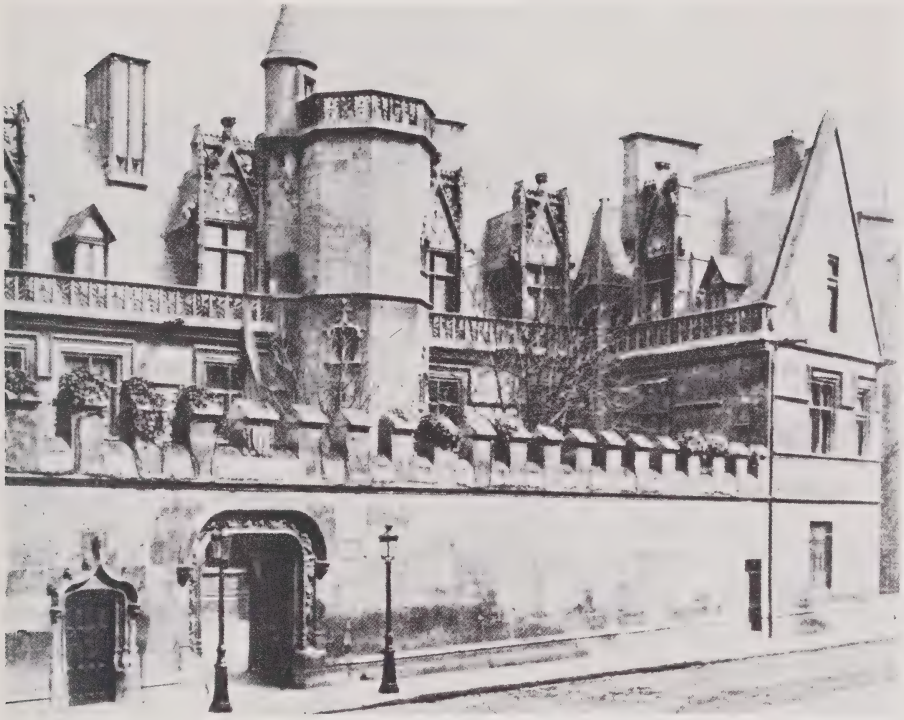
June's calendar shows the Hotel de Nesle in Paris, with labourers in the fields outside its walls. Again, in spite of the castellated architecture, large windows indicate increasing emphasis on the domestic appointments. This is true also in the illumination showing the castle at Poitiers for the month of July, and the August miniature of the great mediaeval fortress at Etampes with its donjon of about 1160. Even here the domestic aspect is stressed. The castle of Saumur appears in the September calendar illumination. This illustration was not finished until some 70 years after the others, and it shows a structure already more a palace than a fortification. We cannot find the battlements and the crenellated parapets quite convincing.

Another miniature shows Mehun-sur-Yevre, built largely in the years around 1367-1390 and now a ruin. In the Très Riches Heures it is a frothy concoction of spires, gables, pinnacles and tracery, piled layer upon layer with an airy delicacy reminiscent of the finest of jeweller's work. It is the architectural equivalent of the splended raiment worn by the lords and ladies in the April miniatures.

The life depicted in the Très Riches Heures is quite clearly set in the country more than in the city. Yet the Duke, one of the richest, most

This Très Riches Heures miniature of Dourdan shows how 15th-century alterations transformed the grim castle of the 1220s into a luxurious and ornate dwelling. Courtesy of Musée Condé

The June miniature (far right) shows the Hôtel de Nesle in Paris. Courtesy of Musée Condé



Hôtel de Cluny in Paris, a townhouse retaining the crenellations of a castle, 1485. From Fletcher's A History of Architecture, *courtesy The Athlone Press of the University of London.*

powerful men of his time, and an avid connoisseur and patron of the arts, enjoyed a mode of living characteristic of an urban setting. The many luxuries with which he surrounded himself were the products of a blossoming urban culture. The old manor of the earlier mediaeval period, with its attempts at self-sufficiency, could not have produced the gorgeous raiment, the tapestries, the intricate metalwork made possible by an urban system based upon trade, commerce, and specialized and often highly technical professions.

The burgeoning society of the Italian Renaissance was already essentially urban rather than agricultural. Even before the 15th century, many of the cities of northern and central Italy had become virtually autonomous city states, and by the 15th century urban life had reached a high point of development. These cities, the centres of Italian social and economic life, drew the feudal nobles into their midst. They left their isolated rural castles and moved into the cities to become neighbours of the non-noble burghers. Wealth and political power came to balance the importance of birth, and even outstanding ability in literary or artistic spheres might be sufficient for admission into the homes of the noble or the rich.

The nobleman of the spirit of the Italian Renaissance was only in part warrior. Ideally, he was the fully rounded individual, the complete man; a courtier skilled in music, in all forms of physical endeavour, and educated in the classics and in all of the arts.

The ideals of the Renaissance, as they moved westwards and northwards, combined with other factors to significantly alter the role of the old European aristocracy, to gradually transform them into a class of courtiers. The aristocracy of western and northern Europe continued to hold to their castles, but developed within their walls the type of life which had begun to develop in the urban centres of Renaissance Italy. Changes in the manner of warfare, including the general adoption through the 15th century of gunpowder, rendered the

fortified castle obsolescent. In the early 16th century there was for a time a tendency to retain the image of fortifications, even though the residential character was often predominant. Crenellations and towers became romantic evocations of an earlier period, still treasured in memory but no longer real. We have seen the beginning of this trend illustrated in the Très Riches Heures of the Duc de Berri. By the 16th century, the French had carried the trend still further in the sumptuous chateaux of the Loire, culminating in the glorious Fontainebleau, carried out almost entirely by Italian artists between 1528 and 1558.

Some of the Loire chateaux were remodelled and reconstructed mediaeval buildings; others were new from the foundations up. In general they share the characteristics of palace architecture in country surroundings. Many still retain the ground plans and crenellation derived from the mediaeval castle, but the towers and walls serve an aesthetic and psychological purpose rather than a military one. Real power had shifted into other spheres, and so the castle, like the tournament, took on a symbolic rather than a purely functional role. It became a visual showpiece. The Loire chateaux increasingly functioned as residences, reflecting the power of their owners and builders less by cold walls and forbidding towers than by extravagant display of wealth and the decorative arts.

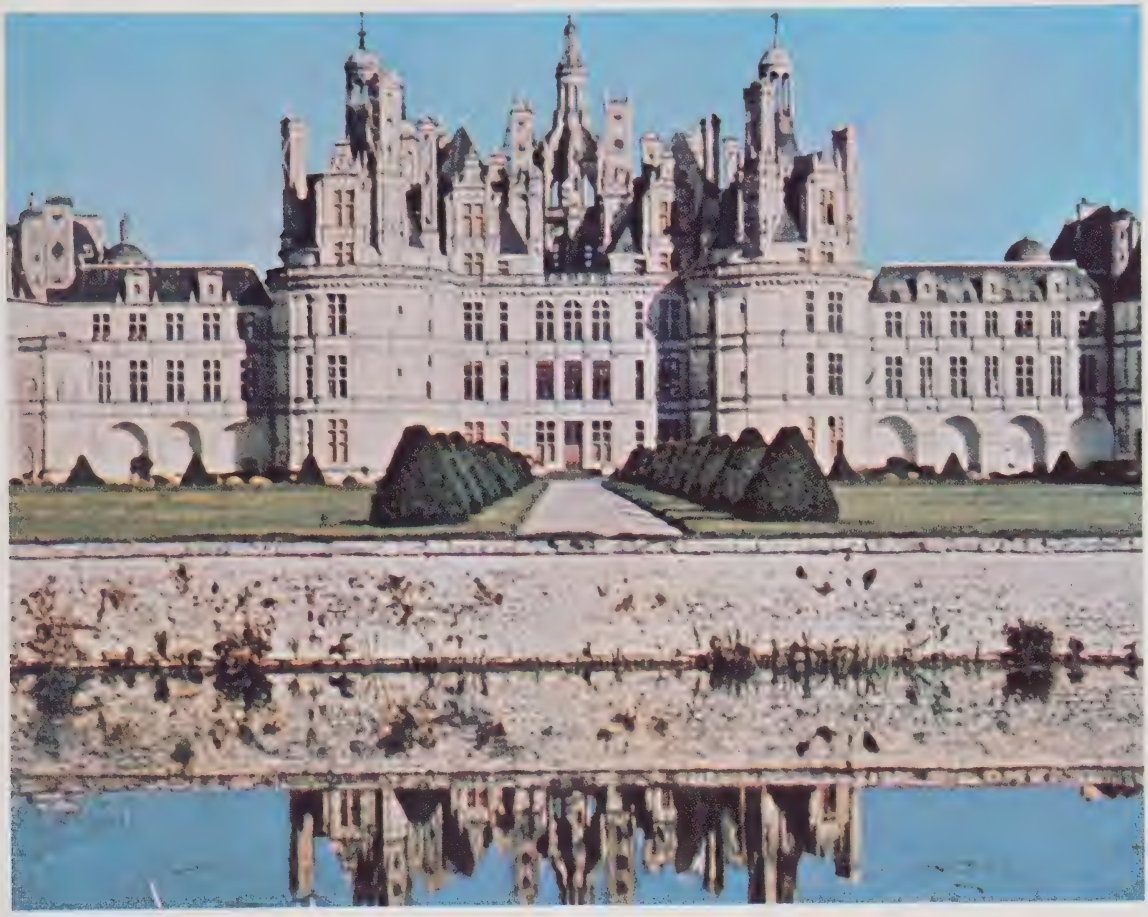
The chateau of Amboise, many times destroyed and rebuilt, became a royal residence in 1434. In the later 1400s, Charles VIII spent large sums of money in building and decorating at Amboise, and little of the earlier mediaeval buildings survived. There were later additions by Louis XII and Francis I. Amboise became the centre of activity of a colony of artists from Italy who helped to combine the style of the Italian Renaissance with the native traditions of France to create a French Renaissance style of art.

Gaillon, about 30 miles southeast of Rouen, was built between 1497 and 1510 by the Cardinal Archbishop of Rouen on the site of an older structure. The new edifice was of such splendour that in the 16th century it became the custom to refer to any impressive country estate by comparing it with Gaillon, as a later generation would make comparisons with Versailles.

Chenonceaux and Azay-le-Rideau were both begun in the first third of the 16th century and are among the most perfect examples of Loire chateau architecture, while Chambord is surely one of the most famous. At Chambord, Francis I was unhampered by the presence of any previous building and the chateau was built as a completely new building in the 1520s, in plan reminiscent of a concentric mediaeval fortress with a central block contained within a rectangular court. A drawing published in 1576 shows an elaborate profusion of forms reminiscent of Gothic architecture, heavily overlaid with Renaissance ornament. One of the most striking features is the incredible opulence and complexity of the skyline with its riot of dormers, chimneys and lanterns. The building was clearly intended as a palatial royal residence, and yet the retention of the castellar ground plan and the use of cylindrical drum towers is typical of the manner in which two different concepts of the chateau became inextricably blended.

As the 16th century progressed and the impact of the Renaissance was heightened, the chateaux of France lost the quaint romantic-mediaevalism of Chenonceaux and Azay-le-Rideau and became more classical in plan, and yet something of the earlier nature of the chateau still peeps through at times, albeit heavily disguised. Even in some of the 17th-century buildings of François Mansart, in spite of the use of classical orders, in spite of the domesticity of the building, there is in the blocking of its wings, in the arrangement of roofs and chimneys, and above all in the verticality of its components, an echo of a much earlier style, the style of the castle. It is a type of architecture which is forever wedded to the country, and which depicts the efforts of an aristocratic class to take the highest forms of the urban-centred culture of the renaissance and transfer them to the country.

Chambord (c. 1520), a royal palace retaining the ground plan and drum towers of the castle tradition. Courtesy Wilhelm Andermann Verlag, Munich.



K. Corey Keeble, Curatorial Assistant in the European Department, came to the ROM in 1969 by way of Winnipeg, and the Courtauld Institute of Art of the University of London. Mr. Keeble's interests are wide-ranging: small bronze sculpture of the Renaissance (ROTUNDA, Spring, 1971), castles and chateaux, the evolution of fashionable dress (a manuscript in progress) and the theatre.

ECLIPSE AT LOIYENGALANI

ELIZABETH LOPIANOWSKA

At 3 o'clock in the afternoon the equatorial sun was already well past the meridian, but still beat down with dizzying intensity on the barren sands that surround Lake Rudolph, the lush emerald-green ribbon that languishes in the deserts of northern Kenya. Its waters nourish some of the largest Nile Perch in the world, along with other fish and reportedly some 22,000 crocodiles. They also quench the thirst of the handful of Samburu and Elmolo tribesmen and their herds that live on its southeastern shore, but the troth between the lake and the land goes no further. Handfuls of grasses do grow scantily on portions of the shoreline, but beyond its shores is desert.

The fact that Lake Rudolph is there, so glaringly out of harmony with the surrounding barrenness, mitigates the overwhelming alienness of the desert, reduces its scale and transforms its threatening allure into something enchanting and exquisite. The desert around Lake Rudolph is not all brown, baked sand. In places it is billowy and golden yellow; in others it is coarse, white and rocky, and nestles the roots of dried thorn trees that show no sign of life. Or it can be granular greenish sand

Totality, the solar eclipse of 1973 over northern Kenya (RB)

Lake Rudolph

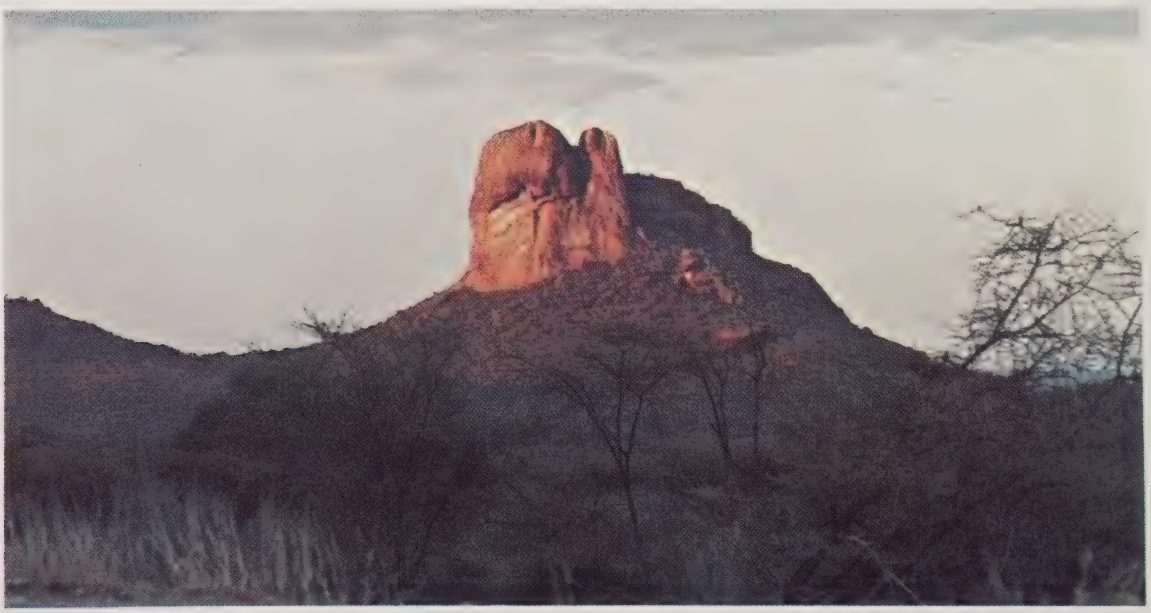
with hints of iridescence. Or, yet again, miles upon miles of rounded black basaltic boulders of various sizes, piled in huge mounds or stretching out flat to the horizon, the most recent exhalations of the volcanoes whose craters still dot parts of this magical land.

About a mile from the eastern shore of the lake is the oasis of Loiyengalani, with the usual assortment of defiant palms and shrubs that are always such an astonishing sight in parching deserts. It is the site of an abandoned safari camp now inhabited by some Catholic missionaries, some 80 members of the indigenous tribes, and the essential camels, cattle and goats.

On the shore of the lake the animals and birds were feeding and drinking as they always do at this time of day, every day of the year. The waters of Lake Rudolph stretch to the horizon in the west, through a wide channel formed by rocky and dusty hills that encroach on its shores at that point. To the immediate south, east and north is what appears from that vantage point as a ring of low hills. The effect is that of a shallow pit completely encircled by high land except where the lake stretches to the west.

About 4 o'clock, there was a cloud bank sitting heavily over the hills to the north, and a single fluffy wisp of cloud had just drifted eastward off the face of the sun, restoring to it its dazzling brightness. And then, without warning except to those who were forewarned and anticipating, the entire scene was transformed into the kind of unearthly vision that, to most people, is granted only through the medium of a skilfully and iconoclastically wielded palette and paint brush, or perhaps photographic devices.

In the space of a couple of minutes, the light level decreased markedly, and in the darkening sky where the familiar blaze of the sun had been there was a round black disc ringed with steady flames of light. With each passing second the sky grew darker, and the hills to the south, east and north were bathed in the colours of sunset; first gold, then pink, then a lilac that would have deepened into the familiar purples and crimsons of sunsets if the source that made this rainbow display possible



Volcanic activity of the past has left odd shapes of rock jutting out from mounds of lava (WP)

had not been virtually extinguished.

To those accustomed to the constancy of a typical day on the tropical shores of Lake Rudolph, this transformation could only be a harbinger of nightfall, if not of a premature end to all days. And in typical mute obedience to the commands of a stereotyped set of instincts, the grazing cattle turned away from the lake to start up the sloping dusty hills and head home before all sunlight disappeared.

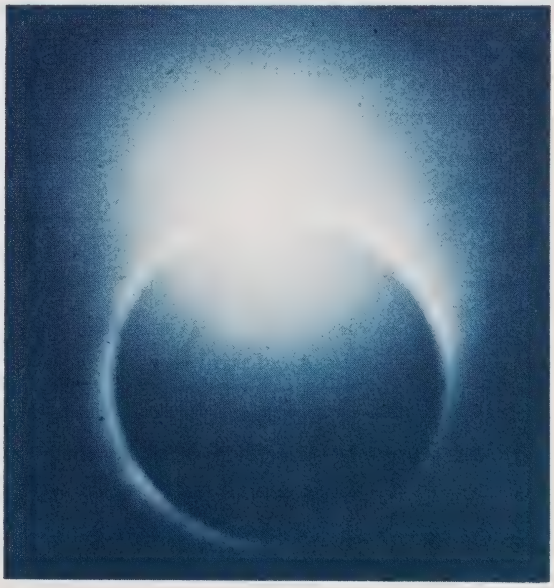
The waters of the lake, normally the colour of sulking emeralds, had turned a deep indigo. Their rippling surface shimmered with a cold, bright, white light, much whiter and colder than even bare starlight could elicit from them. The sand and gravel that crunches underfoot had developed a tarnish, and as the metallic grey tint deepened, a prolonged shiver seemed to pass through the land. The temperature was, in fact, dropping, and a wind had arisen, but it was not a chill that made the land seem to tremble. It was very subtle, very long, parallel bands of shadows which created that illusion as they raced in all directions and made the solid earth seem as unstable as the surface of the lake.

The climax to this complete disruption of the familiar nocturnal/diurnal routine of our Earth occurred in the skies—the same skies which we rely on for the predictability of our days and nights. There where the sun had been struggling to give off its light in the face of the black mass that obstructed it, was the biggest and most brilliant diamond ring that could be imagined, all the more dazzling for the black sky that was its background. It shone and sparkled for a few seconds, and then, all this hallucinatory atmospheric activity ceased as suddenly as it had begun, and the scene stabilized into one of semi-night. The source of what little light there was was that perfectly round ring of asymmetrical neon-white streaks in the very dark sky, starless except for one very familiar 'wandering star,' Venus.

The serene hush that now came to hang over the land lasted for more than five minutes, to be succeeded suddenly by renewed confusion. It was as though someone very smartly smacked the cheeks of this dreaming land, and it awoke with a startle to the kind of hot and dusty afternoon that is both its curse and the only reality it knows. The sun quickly regained its composure to shine as cruelly as it always does here, restoring to the waters of Lake Rudolph their absurdly rich and vibrant colour. The cattle, by now halfway home, paused to assess the situation, and failing to come to any conclusion remained where they were, presumably on the assumption that someone would come along to tell them what to do.

Two hours later the sun set with its usual equatorial efficiency—very quickly and at a perfect right angle to the horizon, defined at Loiyengalani by the lake. A half-hour later it was dark. Thousands of stars appeared on the velvet-black background, and under this friendly and familiar canopy the events of that afternoon took on a more and more unconvincing cast of fiction. The total eclipse of the sun by the moon of June 30, 1973, heralded quite rightly as the greatest eclipse of the century, had come and gone.

Eclipses of the sun, partial or total, are common events to the astronomer, for they occur



The diamond ring effect, lasting for a moment before and after totality (RB)

Dawn and twilight are of very short duration on the equator, but the rising and setting of the sun are always spectacular

at least once every year. The paths of totality that eclipses follow are not very wide, usually about 50 miles, but the shadow of the moon during the eclipse follows a balloon-shaped path that can be up to one quarter of the diameter of Earth in width. So it is that most people over the age of 40 have had an opportunity to witness an eclipse, at least in its partial aspects. Many of these, upon learning of a coming eclipse, have armed themselves with thick welder's glass or several layers of unexposed film, waited and watched expectantly, and been very disappointed. When future ones are announced, they only shrug their shoulders, convinced by their own experience that there is nothing to get excited about.

Total solar eclipses, where the moon for some periods of time completely covers the disc of the sun, are unspectacular when seen from outside the boundaries of the path of totality, because from most vantage points on the surface of Earth they appear as only partial eclipses. In such cases, the moon covers only a portion of the surface of the sun, and one could contentedly go through a sunny day without being aware that the sun had been eclipsed at all. There is little if any darkening, depending on the distance of the observation site from the centre of the path of totality. The eclipse itself, the dark body of the moon against the sun, is visible to best advantage only through appropriate filters which block out the pervading blazing glare of the sun.

There is also an infrequent variety of total eclipse which even when seen from vantage points along the path of totality, is not overly impressive. This is the annular eclipse, in which the moon comes completely between us and the sun, and blocks out much of the sun's light with no part of its surface extending beyond the perimeter of the sun's disc. This phenomenon is quite visible to the unaided eye. The moon is clearly silhouetted as a perfectly round black disc against the radiant background of the sun's light. But even this is hardly spectacular, since all that happens is that for a short period of time the sky is dominated by a black disc ringed with very bright light. Beautiful, unusual, but not spectacular.

It is one of those grand cosmic flukes that, at so many points in its orbit, our moon as seen from Earth appears to be exactly the same size as the sun. And it is those eclipses which occur during this fortunately frequent combination of circumstances which are the potentially magnificent ones. In such cases, for those watching from the path of totality, the moon completely covers the entire surface of the disc of the sun, rendering only the brilliant corona visible and bringing about all the at-

One of the watering holes at the oasis of Loiyengalani

tendant phenomena which make the event such a stunning, exhilarating and, to many, even a mystical affair.

The eclipse of June 30, 1973 was one of these special eclipses, and what made it particularly special among its kind was the fact that at certain points in its path, totality was to last over seven minutes.

The eclipse was first to be seen from the northeast coast of South America, beginning at sunrise, and those who happened to be in the middle of the Indian Ocean in the late afternoon were the last to see it, at sunset.

Since it was to be such a long eclipse, preparations for viewing it started some two years ago, when the U.S. National Science Foundation sent out research teams to investigate possible observation and experimentation sites. Since the eclipse would be at peak durations while passing over the continent of Africa, it is here that the most intensive research took place. Two sites were selected as the best according to various criteria, but the eventual choice of site was dictated more by personal taste than scientific data. Boats off the west coast of Africa seem to have been the most popular choice, since a large mass of water tends to steady hot air and since boats can move to a different location should a cloud obscure the view. Mauritania was a close second, because totality would last well over six minutes and because, although it is desert country, parts of it remain relatively free of the dust-laden and almost smoggy air over the Sahara.

Those with the means, financial and otherwise, opted for a third "site," the flight of the prototype supersonic transport, the Concorde, which promised and gave an experience of totality over an hour long. Eventually, however, a fourth site which had initially been ignored came to be considered a viable alternative—and the southeastern shore of Lake Rudolph in northern Kenya seems to have turned out to be the best. The physical setting was idyllic, and the skies were clear in spite of the desert which surrounds it.

But, whatever location they chose, scientists and non-scientists alike travelled thousands of miles to witness this celestial phenomenon that was billed as the most spectacular event to be seen in our skies this century. And those who have never seen a total solar eclipse, or been subjected to the rantings of enthusiasts who have, may be surprised that such eclipses, wherever on our planet they happen to occur, attract as many non-scientists as scientists. And of these non-scientists, not many are even amateur astronomers.

At Loiyengalani there gathered about 1500 people. There was the usual army of U.S. National Science Foundation scientists and technicians, who of course staked off the best observing terrain for themselves and forbade access to it. There were also other scientific groups. But there was also a motley array of ordinary people, and among them a surprising number of Torontonians, most of them there for pleasure alone. Robert Ballantyne and William Peters, both of the McLaughlin Planetarium, were there, and contributed some of their photographs to this article.

It may be hard to convince those who have never seen a total eclipse of the sun that all the insanity and expenditure of travelling far to find one is worth it. But those initiated into the experience, and even addicted to it, will travel almost anywhere to see one, because to wait up to 360 years for an eclipse to come to them would be quite literally unendurable.

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Our error

In the previous issue of *Rotunda*, the gremlin that stalks unwary editors struck *"Money Alone Sets All the World in Motion,"* by Alison Harle Easson. Obverse and reverse illustrations of the silver stater of Sybaris, on page 27, were transposed, as were the illustrations of the silver tetradrachm of Perseus of Macedon (page 29) and that of Ptolemy V of Egypt (page 30). The captions, however, the gremlin left in their correct positions.

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